THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Yoshito KURODA

Serial No. : 10/500,882

Filed : July 7, 2004

For : METHOD FOR PRODUCING HIGH PURITY GLYCOLIC ACID CRYSTALS

Art Unit : 1621

Examiner : Karl J. Puttilitz

DECLARATION

I, Yoshito KURODA, a Japanese citizen residing at Horinan 814-12, Kurashiki-shi, Okayama-ken, Japan, declare and say:

I was graduated from the graduate school (master course) of the Department of Applied Chemistry, Faculty of Engineering, Tohoku University, Japan, in March 1994.

I entered Asahi Kasei Kogyo Kabushiki Kaisha in April 1994. I have been engaged in the research and development of condensation resins from April 1994 to date.

I am one of the applicants of the above-identified application and I am well familiar with the present case.

I have read and understood the Office Action dated December 23, 2005 issued in the present case and the reference cited therein.

I carried out Examples 1 to 5 and Comparative Examples 1 to 6 of the present application.

I have made observations on the criticality of characteristics (a), (b) and (c) of aqueous glycolic acid solution (A) defined in the present invention for producing **high purity** glycolic acid crystals easily and in **high yield** within a **short crystallization time**. The method and results are as described in a paper attached hereto and marked "Exhibit 1".

I have also made observations to show that the excellent effects of the present invention (**high purity, high yield** and **short crystallization time**) are not achieved in WO92/05138 (hereinafter, referred to as "**WO 138**") cited in the outstanding office action, with reference to Examples 1 to 5 of WO92/05138. The method and results are as described in a paper attached hereto and marked "Exhibit 2".

I have also made observations to show that the method of **WO 138** is **disadvantageous** as compared to the method of the

present invention, with reference to Examples 1 and 4 of WO 138 and working examples of the present application. The method and results are as described in a paper attached hereto and marked "Exhibit 3".

From the results of Exhibit 1, it can be fairly concluded:

(1) that, in each of Examples 1 to 5 in which aqueous glycolic acid solutions satisfying the above-mentioned characteristics (a), (b) and (c) were used, there were produced glycolic acid crystals having a purity as high as from 99.90 to 99.97 % in a yield of as high as from 20 to 27 % by weight within a crystallization time as short as from 0.25 to 2 hours;

(2) that, on the other hand, in Comparative Examples 1 to 6 in which aqueous glycolic acid solutions which do not satisfy at least one of the above-mentioned characteristics (a), (b) and (c) were used, there were produced glycolic acid crystals having a purity of only from 99.47 to 99.72 % (i.e., lower than 99.90 %, which is aimed at by the present invention); and

(3) that, from items (1) and (2) above, it is apparent that the above-mentioned characteristics (a), (b) and (c) of aqueous glycolic acid solution (A) are critical for achieving the

excellent effects of the present invention (i.e., producing high purity glycolic acid crystals easily and in high yield within a short crystallization time).

From the results of Exhibit 2, it can be fairly concluded:

(1) that, in Examples 2, 3 and 5 of WO 138, the purity is as low as from 99.3 to 99.8 (vs. 99.90 % by weight, which is aimed at by the present invention);

(2) that, in Example 1 of WO 138, although the purity is 99.9 %, the yield is as low as 6.6 % (vs. 20 % by weight, which is achieved in the working examples of the present application);

(3) that, in Example 4 of WO 138, although the purity is 99.9 %, the crystallization time is disadvantageously long as 63 hours (vs. 0.25 to 2 hours, which is achieved in the present invention); and

(4) that, from items (1) and (3) above, it is apparent that the excellent effects of the present invention (i.e., high purity, high yield and short crystallization time) are not achieved in WO 138.

From the results of Exhibit 3, it can be fairly concluded:

(1) that, in the case where the yield is as low as 6.6 % by

weight (i.e., Example 1 of WO 138), when it is intended to produce a predetermined amount of glycolic acid crystals within a predetermined crystallization time, as can be seen from formula (i) below, the amount of aqueous glycolic acid solution needed for the production will be 3 times the amount of aqueous glycolic acid solution needed in the case where the yield is at least 20 % by weight (i.e., present invention):

$$20/6.6 = 3 \qquad \text{(i)};$$

(2) that, when the amount of glycolic acid solution needed becomes 3 times larger, the energy needed for adjusting temperature (i.e., cooling) during the crystallization step would be at least 3 times larger than the energy needed in the present invention, and it becomes necessary to scale-up the production system;

(3) that, in such a case where the consumed energy becomes 3 times larger, and there is a need to scale-up the production system, the cost would inevitably become disadvantageously high, as compared to the case of the present invention;

(4) that, in the case where the crystallization time is as long as 63 hours, when it is intended to produce a predetermined amount of glycolic acid crystals within a predetermined crystallization time, as can be seen from formula (ii) below,

the amount of aqueous glycolic acid solution needed for the production will be 31.5 times the amount of aqueous glycolic acid solution needed in the present invention (in which the yield is not more than 2 hours):

$$63/2 = 31.5 \qquad \text{(ii)};$$

(5) that, when the amount of glycolic acid solution needed becomes 31.5 times larger, the energy needed for adjusting temperature (i.e., cooling) during the crystallization step would be at least 31.5 times larger than the energy needed in the present invention, and it becomes necessary to scale-up the production system;

(6) that, in such a case where the consumed energy becomes 31.5 times larger, and there is a need to scale-up the production system, the cost would inevitably become disadvantageously high, as compared to the case of the present invention;

(7) that, in the case where the yield is as low as 6.6 % by weight and the crystallization time is as long as 63 hours, when it is intended to produce a predetermined amount of glycolic acid crystals within a predetermined crystallization time, as can be seen from formula (i) below, the amount of aqueous glycolic acid solution needed for the production will be at least 95.5 times larger than the amount of aqueous gly-

colic acid solution needed in the present invention (in which the yield is at least 20 % by weight and the crystallization time is not more than 2 hours):

$$(20/6.6) \times (63/2) = 95.5 \qquad \text{(iii)};$$

(8) that, when the amount of glycolic acid solution needed becomes 95.5 times larger, the energy needed for adjusting temperature (i.e., cooling) during the crystallization step would be at least 95.5 times larger than the energy needed in the present invention, and it becomes necessary to scale-up the production system significantly;

(9) that, in such a case where the consumed energy becomes 95.5 times larger, and there is a need to scale-up the production system, the cost would inevitably become significantly high, as compared to the case of the present invention; and

(10) that, from items (1) to (9) above, it is apparent that the method of WO 138 is disadvantageous as compared to the method of the present invention.

The undersigned petitioner declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

March 15, 2006
Date

Yoshito Kuroda
Yoshito KURODA

Exhibit 1

Observations on the criticality of characteristics (a), (b) and (c) of aqueous glycolic acid solution (A) defined in the present invention for producing **high purity** glycolic acid crystals easily and in **high yield** within a **short crystallization time**, with reference to Examples 1 to 5 and Comparative Examples 1 to 6 of the present application

---

1. The object of observations

The present invention is directed to a method for producing glycolic acid crystals using a specific aqueous glycolic acid solution (A). In the method of the present invention, for producing high purity glycolic acid crystals in a high yield within a short crystallization time, it is critical that aqueous glycolic acid solution (A) has the following **characteristics (a), (b) and (c)**:

(a) a **water content** of from **5 to 20** % by weight;

(b) a **calculated monomeric glycolic acid weight ratio** of from **0.60 to 1.00**, said calculated monomeric glycolic acid weight ratio being defined as a ratio of the total weight of said monomeric glycolic acid and said glycolic acid condensation product to the weight of said aqueous solution (A), wherein the weight of said glycolic acid condensation product

is expressed in terms of the weight of component monomeric glycolic acid of the glycolic acid condensation product; and

(c) a monomeric glycolic acid content of from **20 to 57 %** by weight.

Such high purity glycolic acid crystals cannot be produced in a high yield within a short crystallization time by the conventional methods for producing glycolic acid crystals, in which the aqueous glycolic acid solution used does not satisfy all of the above-mentioned characteristics (a), (b) and (c).

In order to substantiate this, observation is made below, with reference to Examples 1 to 5 and Comparative Examples 1 to 6 of the present application.

2. Observations

Example 1 (page 82, line 25 to page 84, line 11):

Glycolic acid crystals were produced from aqueous glycolic acid solution 1 prepared in Production Example 1 (water content: 18 % by weight; calculated monomeric glycolic acid weight ratio: 0.83; monomeric glycolic acid content: 54.5 % by weight) (see page 76, line 6 to page 77, line 9) at a crystallization time of 0.25 hours (15 minutes). As a result,

glycolic acid crystals having a purity of as high as 99.96 % by weight were obtained in a yield of 27 % by weight.

Example 2 (page 84, lines 13 to 23):

Glycolic acid crystals were produced from aqueous glycolic acid solution 1 prepared in Production Example 1 (i.e., the same aqueous glycolic acid solution as that used in Example 1) at a crystallization time of 0.25 hours (15 minutes). As a result, glycolic acid crystals having a purity of as high as **99.96** % by weight were obtained in a yield of 20 % by weight.

Example 3 (page 84, line 25 to page 85, line 12):

Glycolic acid crystals were produced from aqueous glycolic acid solution 2 prepared in Production Example 2 (water content: 13 % by weight; calculated monomeric glycolic acid weight ratio: 0.91; monomeric glycolic acid content: 52 % by weight) (see page 77, line 11 to page 78, line 5) at a crystallization time of 2 hours. As a result, glycolic acid crystals having a purity of as high as **99.97** % by weight were obtained in a yield of 28 % by weight.

Example 4 (page 85, line 14 to page 86, line 6):

Glycolic acid crystals were produced from aqueous glycolic acid solution 2 prepared in Production Example 2 (i.e., the same aqueous glycolic acid solution as that used in Example 3) at a crystallization time of 2 hours. As a result, glycolic acid crystals having a purity of as high as **99.92** % by weight were obtained in a yield of 28 % by weight.

Example 5 (page 86, lines 8 to 22):

Glycolic acid crystals were produced from aqueous glycolic acid solution 3 prepared in Production Example 3 (water content: 7 % by weight; calculated monomeric glycolic acid weight ratio: 1.0; monomeric glycolic acid content: 41 % by weight) (see page 78, line 7 to page 79, line 1) at a crystallization time of 0.75 hours (45 minutes). As a result, glycolic acid crystals having a purity of as high as **99.90** % by weight were obtained in a yield of 23 % by weight.

Comparative Example 1 (page 86, line 25 to page 88, line 10):

Glycolic acid crystals were produced from comparative aqueous glycolic acid solution 6 (water content: 31 % by weight (outside the range of characteristic (a)); calculated monomeric glycolic acid weight ratio: 0.7; monomeric glycolic

acid content: 59 % by weight (outside the range of characteristic (c))) at a crystallization time of 1.5 hours. As a result, glycolic acid crystals having a purity of only **99.47** % by weight were obtained in a yield of 20 % by weight.

Comparative Example 2 (page 88, lines 12 to 25):

Glycolic acid crystals were produced from comparative aqueous glycolic acid solution 6 (the same aqueous glycolic acid solution as that used in Comparative Example 1, which does not satisfy characteristics (a) and (c)) at a crystallization time of 1.5 hours. As a result, glycolic acid crystals having a purity of only **99.55** % by weight were obtained in a yield of 20 % by weight.

Comparative Example 3 (page 89, lines 2 to 16):

Glycolic acid crystals were produced from comparative aqueous glycolic acid solution 4 produce in Production Example 4 (water content: 3 % by weight (outside the range of characteristic (a)); calculated monomeric glycolic acid weight ratio: 1.05 (outside the range of characteristic (b)); monomeric glycolic acid content: 35 % by weight) at a crystallization time of 1 hour. As a result, glycolic acid crystals having a purity of only **99.68** % by weight were obtained

in a yield of 20 % by weight.

Comparative Example 4 (page 89, line 18 to page 90, line 17):

Glycolic acid crystals were produced from comparative aqueous glycolic acid solution 7 (water content: 19 % by weight; calculated monomeric glycolic acid weight ratio: 0.84; monomeric glycolic acid content: 65 % by weight (outside the range of characteristic (c))) at a crystallization time of 0.75 hours (45 minutes). As a result, glycolic acid crystals having a purity of only **99.69** % by weight were obtained in a yield of 23 % by weight.

Comparative Example 5 (page 90, line 19 to page 92, line 3):

Glycolic acid crystals were produced from comparative aqueous glycolic acid solution 8 (water content: 23 % by weight (outside the range of characteristic (a)); calculated monomeric glycolic acid weight ratio: 0.75; monomeric glycolic acid content: 55 % by weight) at a crystallization time of 0.75 hours (45 minutes). As a result, glycolic acid crystals having a purity of only **99.72** % by weight were obtained in a yield of 14 % by weight.

Comparative Example 6 (page 92, line 5 to 5):

Glycolic acid crystals were produced from comparative aqueous glycolic acid solution 6 (water content: 6 % by weight; calculated monomeric glycolic acid weight ratio: 1.02 (outside the range of characteristic (b)); monomeric glycolic acid content: 34% by weight) at a crystallization time of 0.75 hours (45 minutes). As a result, glycolic acid crystals having a purity of only 99.70 % by weight were obtained in a yield of 22 % by weight.

For easy reference, the results of Examples 1 to 5 and Comparative Examples 1 to 6 are summarized in Table A below:

Table A

	Glycolic acid solution used in deposition step			Deposition step	Glycolic acid crystals produced	
	Water content (wt%) (Characteristic (a): 5-20 wt%)	calculated monomeric glycolic acid weight ratio (Characteristic (b): 0.6-1)	monomeric glycolic acid content (wt%) (Characteristic (c): 20-57]	Crystallization time (hours)	Yield (wt%)	Purity (wt%)
Ex. 1	18	0.83	54.5	0.25	27	99.96
Ex. 2	18	0.83	54.5	0.25	20	99.96
Ex. 3	13	0.91	52	2	28	99.97
Ex. 4	13	0.91	52	2	28	99.92
Ex. 5	7	1.00	41	0.75	23	99.90
Comp. Ex. 1	31 (*1)	0.70	59 (*3)	1.5	20	99.47
Comp. Ex. 2	31 (*1)	0.70	59 (*3)	1.5	20	99.55
Comp. Ex. 3	3 (*1)	1.05 (*2)	35	1	20	99.68
Comp. Ex. 4	19	0.84	65 (*3)	0.75	23	99.69
Comp. Ex. 5	23 (*1)	0.75	55	0.75	14	99.72
Comp. Ex. 6	6	1.02 (*2)	34	0.75	22	99.70

Notes: (*1) outside the range of characteristic (a)
(*2) outside the range of characteristic (b)
(*3) outside the range of characteristic (c)

3. Conclusion

From Table A above, it is apparent that in each of Examples 1 to 5 in which aqueous glycolic acid solutions satisfying the above-mentioned characteristics (a), (b) and (c) were used, there were produced glycolic acid crystals having a **purity as high as from 99.90 to 99.97 %** in **a yield of as high as from 20 to 27 % by weight** within a **crystallization time as short as from 0.25 to 2 hours**.

On the other hand, in Comparative Examples 1 to 6 in which aqueous glycolic acid solutions which do not satisfy at least one of the above-mentioned characteristics (a), (b) and (c) were used, there were produced glycolic acid crystals having a **purity of only from 99.47 to 99.72 % (i.e., lower than 99.90 %, which is aimed at by the present invention)**.

From the above, it is apparent that the above-mentioned characteristics (a), (b) and (c) of aqueous glycolic acid solution (A) are **critical** for achieving the excellent effects of the present invention (i.e., producing **high purity** glycolic acid crystals easily and in **high yield** within a **short crystallization time**).

Exhibit 2

Observations to show that the excellent effects of the present invention (**high purity**, **high yield** and **short crystallization time**) are not achieved in WO92/05138 cited in the outstanding office action, with reference to Examples 1 to 5 of WO92/05138

---

1. The object of observations

The present invention is directed to a method for producing glycolic acid crystals using a specific aqueous glycolic acid solution (A). In the method of the present invention, for producing high purity glycolic acid crystals in a high yield within a short crystallization time, it is critical that aqueous glycolic acid solution (A) has **(a)** a **water content** of from **5 to 20** % by weight; **(b)** a **calculated monomeric glycolic acid weight ratio** of from **0.60 to 1.00**; and **(c)** a **monomeric glycolic acid content** of from **20 to 57** % by weight.

As described in **Exhibit 1** of the accompanying executed Mr. Kuroda declaration, such high purity glycolic acid crystals cannot be produced in a high yield within a short crystallization time by the conventional methods for producing glycolic acid crystals, in which the aqueous glycolic acid

solution used does not satisfy all of the above-mentioned characteristics (a), (b) and (c).

In **WO92/05138** (hereinafter, referred to as "**WO 138**") cited in the outstanding office action, the aqueous glycolic acid solution used is a 70 % technical grade aqueous solution (see page 3, lines 14 to 15 of **WO 138**). That is, the glycolic acid solution produced in **WO 138** has a water content of **30** % by weight, which is outside the range of characteristic **(a)** (5 to 20 % by weight) defined in claim 1 of the present application. Therefore, in **WO 138**, the excellent effects of the present invention (**high purity**, **high yield** and **short crystallization time**) are not achieved.

In order to substantiate this, observation is made below, with reference to Examples 1 to 5 of **WO 138**.

2. Observations

Example 1 (page 7, lines 2 to 15):

Glycolic acid crystals were produced from a 70 % by weight aqueous glycolic acid solution (water content: 30 % by weight (outside the range of characteristic (a))) at a crystallization time of as long as 24 hours. As a result, glycolic acid crystals having a purity of as high as 99.9 % by weight were obtained in a yield of only 6.6 % by weight.

Example 2 (page 74, lines 16 to 31):

Glycolic acid crystals were produced from a 70 % by weight aqueous glycolic acid solution (water content: 30 % by weight (outside the range of characteristic (a))) at a crystallization time of 0.25 hours (15 minutes). As a result, glycolic acid crystals having a purity of only 99.4 % by weight were obtained in a yield of 23.6 % by weight.

Example 3 (page 7, line 32 to page 8, line 15):

Glycolic acid crystals were produced from a 70 % by weight aqueous glycolic acid solution (water content: 30 % by weight (outside the range of characteristic (a))) at a crystallization time of as long as 5 hours. As a result, glycolic acid crystals having a purity of only 99.3 % by weight were obtained in a yield of 16.7 % by weight.

Example 4 (page 8, line 16 to page 9, line 13):

Glycolic acid crystals were produced from a 70 % by weight aqueous glycolic acid solution (water content: 30 % by weight (outside the range of characteristic (a))) at a crystallization time of **as long as 63 hours**. As a result, glycolic acid crystals having a purity of only 99.4 % by weight

were obtained in a yield of 27 % by weight.

Example 5 (page 9, lines 14 to 33):
Glycolic acid crystals were produced from a 70 % by weight aqueous glycolic acid solution (water content: 30 % by weight (outside the range of characteristic (a))) at a crystallization time of **as long as 65 hours**. As a result, glycolic acid crystals having a purity of only 99.8 % by weight were obtained in a yield of 19 % by weight.

For easy reference, the results of Examples 1 to 5 of **WO 138** are summarized in Table B below:

Table B

		Purity (wt %)	Yield (wt %)	Crystallization time (Hours)
Working examples of **WO 138**	Ex. 1	99.9	**6.6**	24
	Ex. 2	99.**4**	23.6	0.25
	Ex. 3	99.**3**	16.7	5
	Ex. 4	99.9	27	**63**
	Ex. 5	99.**8**	19.0	65
Working examples of the **present application**		99.90 to 99.97	20 to 27	0.25 to 2

3. Conclusion

From Table B above, it is apparent that in Examples 2, 3 and 5 of **WO 138**, the purity is as low as from 99.**3** to 99.**8** (vs. 99.**90** % by weight, which is aimed at by the present invention).

On the other hand, in Example 1 of **WO 138**, although the purity is 99.9 %, the **yield** is as low as **6.6** % (vs. 20 % by weight, which is achieved in the working examples of the present application).

Further, in Example 4 of **WO 138**, although the purity is 99.9 %, the **crystallization time** is disadvantageously long as **63 hours** (vs. 0.25 to 2 hours, which is achieved in the present invention).

From the above, it is apparent that the excellent effects of the present invention (i.e., **high purity**, **high yield** and **short crystallization time**) are not achieved in **WO 138**.

Exhibit 3

Observations to show that the method of **WO92/05138** cited in the outstanding office action is **disadvantageous** as compared to the method of the present invention, with reference to Examples 1 and 4 of **WO 138** and working examples of the present application

---

1. The object of observations

The present invention is directed to a method for producing **high purity** glycolic acid crystals (i.e., glycolic acid crystals having a **purity of 99.9 by weight or more**) in a **high yield** within a **short crystallization time**. Such high purity glycolic acid crystals can be obtained only by the use of an aqueous glycolic acid solution (A) having **(a)** a **water content** of from **5 to 20** % by weight; **(b)** a **calculated monomeric glycolic acid weight ratio** of from **0.60 to 1.00**; and **(c)** a **monomeric glycolic acid content** of from **20 to 57** % by weight (see Exhibit 1 of the accompanying executed Mr. Kuroda declaration).

In **WO92/05138** (hereinafter, referred to as "**WO 138**") cited in the outstanding office action, the aqueous glycolic acid solution used does not satisfy the above-mentioned characteristic **(a)** (water content of 5 to 20 % by weight). Therefore, in **WO 138**, the excellent effects of the present

invention (**high purity, high yield** and **short crystallization time**) are not achieved (see Exhibit 2 of the accompanying executed Mr. Kuroda declaration).

In order to show that the method of **WO 138** is **disadvantageous** as compared to the method of the present invention, observation is made below, with reference to Examples 1 and 4 of **WO 138** and working examples of the present invention.

2. Observations

Firstly, attention is drawn to Examples 1 and 4 of **WO 138**.

In Example 1 of **WO 138**, although the purity is as high as 99.9 % (which is aimed at by the present invention), the **yield** is as low as **6.6 % by weight** (vs. **20 % by weight** achieved in the working examples of the present application).

On the other hand, in Example 4 of **WO 138**, although the purity is as high as 99.9 %, the crystallization time is as long as **63 hours** (vs. **0.25 to 2 hours** achieved in the working examples of the present application).

With respect to the disadvantages of such a low yield and a long crystallization time, the following should be noted.

(1) In the case where the yield is as low as **6.6 % by**

weight (i.e., Example 1 of **WO 138**), when it is intended to produce a predetermined amount of glycolic acid crystals within a predetermined crystallization time, as can be seen from formula (i) below, the amount of aqueous glycolic acid solution needed for the production will be **3 times** the amount of aqueous glycolic acid solution needed in the case where the yield is at least **20 % by weight** (i.e., present invention):

$$20/6.6 = 3 \qquad \text{(i)}$$

When the amount of glycolic acid solution needed becomes 3 times larger, the **energy** needed for adjusting temperature (i.e., cooling) during the crystallization step would be **at least 3 times larger** than the energy needed in the present invention. Further, when the amount of glycolic acid solution needed becomes 3 times larger, it becomes necessary to **scale-up the production system**. Needless to say, in the production of glycolic acid crystals on a commercial scale (e.g., plant production), in such a case where the consumed energy becomes 3 times larger, and there is a need to scale-up the production system, the **cost** would inevitably become disadvantageously **high**, as compared to the case of the present inven-

tion.

(2) In the case where the crystallization time is as long as **63 hours**, when it is intended to produce a predetermined amount of glycolic acid crystals within a predetermined crystallization time, as can be seen from formula (ii) below, the amount of aqueous glycolic acid solution needed for the production will be **31.5 times** the amount of aqueous glycolic acid solution needed in the present invention (in which the yield is not more than **2 hours**):

$$63/2 = \mathbf{31.5} \qquad \text{(ii)}$$

When the amount of glycolic acid solution needed becomes 31.5 times larger, the **energy** needed for adjusting temperature (i.e., cooling) during the crystallization step would be **at least 31.5 times larger** than the energy needed in the present invention. Further, when the amount of glycolic acid solution needed becomes 31.5 times larger, it becomes necessary to **scale-up the production system**. Needless to say, in the production of glycolic acid crystals on a commercial scale (e.g., plant production), in such a case where the consumed energy becomes 31.5 times larger, and there is a need to scale-up the production system, the **cost** would inevitably become disadvantageously **high**, as compared to the case of the present invention.

(3) Further, for reference, in the case where the yield is as low as **6.6 % by weight** and the crystallization time is as long as **63 hours**, when it is intended to produce a predetermined amount of glycolic acid crystals within a predetermined crystallization time, as can be seen from formula (i) below, the amount of aqueous glycolic acid solution needed for the production will be **at least 95.5 times larger** than the amount of aqueous glycolic acid solution needed in the present invention (in which the **yield** is **at least 20 % by weight** and **the crystallization time is not more than 2 hours**):

$$(20/6.6) \times (63/2) = \mathbf{95.5} \qquad \text{(iii)}$$

When the amount of glycolic acid solution needed becomes 95.5 times larger,, the **energy** needed for adjusting the temperature (i.e., cooling) during the crystallization step would be **at least 95.5 times larger** than the energy needed in the present invention. Further, when the amount of glycolic acid solution needed becomes 95.5 times larger, it becomes necessary to **scale-up the production system significantly.** Needless to say, in the production of glycolic acid crystals on a commercial scale (e.g., plant production), when the consumed energy becomes 95.5 times larger, and there is a need to scale-up the production system significantly, the **cost**

would inevitably become disadvantageously **high**, as compared to the case of the present invention.

3. Conclusion

From the above, it is apparent that the method of **WO 138** is **disadvantageous** as compared to the method of the present invention.